Microblade Technology in Korea and Adjacent Northeast Asia

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THE LATE PLEISTOCENE ARCHAEOLOGICAL RECORD of northeast Asia shows an overwhelming dominance of microlithic assemblages. It is believed that similar microblade technology spread throughout the vast region of northeast Asia, including Mongolia, north China, eastern Siberia, Korea, and Japan, and northwestern North America (see Figs. 1 and 2). Microliths are even found in high elevation areas above 4000 m in the Tibetan Plateau (Gai 1985 : 230). In addition to this wide distribution, these industries persisted through the Neolithic and Bronze Age into historic periods.

Although the term "microlithic" may have different implications to different scholars and in local research traditions, there seems to be a general agreement to reserve the term for those assemblages that contain microblades and microcores, as well as small scrapers and end-scrapers. Following this widely shared convention, the present study will use the concept of microlithic to indicate lithic assemblages containing microliths, i.e., microblades, and/or microblade cores.

The sophistication and development of microlithic technology are well reflected in the small-sized blades, which are believed to have been used in composite tools. Microblades, compared with (antecedent) "normal" blades, are small and "thin strips" of rock detached from specially prepared cores by indirect or pressure flaking. They are about 2 mm thick with parallel sides of about 4–7 mm width and 15–50 mm length (Gai 1985; Kato and Tsurumaru 1980). Width is the most important criterion for defining the microblade: those less than 1 cm width will be identified as microblades.

The central interest of investigations in the microlithic has been directed toward technological-typological aspects of microblade cores. Various issues ranging from technological reconstruction to the peopling of the Americas have been discussed through the examination of variability of microblade cores. Compared with research histories in China, Japan, Russia, and North America, however, microlithic research was rather late in coming to the Korean Palaeolithic. In the 1960s, microblade cores were reported at Kulpo and Sokchang, the first two Palaeolithic sites excavated in North and South Korea respectively by

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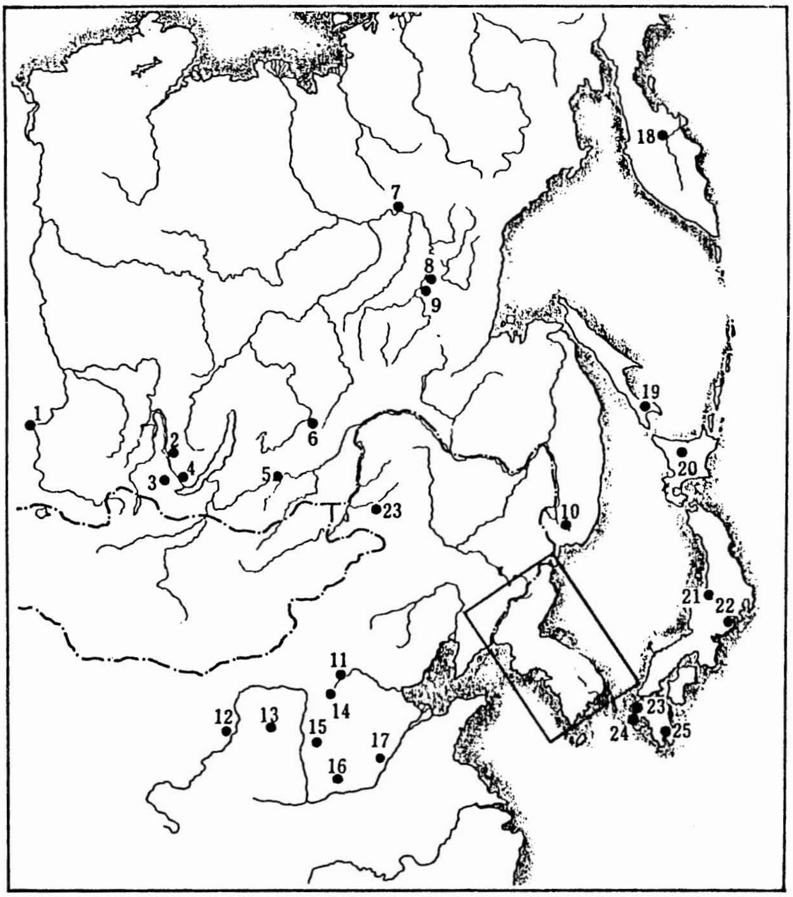

Fig. 1. Some microlithic localities in northeast Asia: 1. Novos'lovo, 2. Krasniy Yar, 3. Sosnovy Bor, 4. Verkholenskoya Gora, 5. Sokhatino, 6. Noviy Lenten II, 7. Ikhine I, II, 8. Verkhnetroitskaya, 9. D'uktai (Dyuktai), 10. Irystaya, 11. Hutouliang, 12. Shuidonggu, 13. Salawusu, 14. Shiyu, 15. Xueguan, 16. Xiachuan, 17. Xiaonanhai, 18. Ushki, 19. Sokol, 20. Shiradaki, 21. Yadegawa, 22. Yasumiba, 23. Sempukuji, 24. Fukui, 25. Funano. (Based on Larichev et al. 1990, 1992; Shiraishi 1993; Tang and Gai 1985.)

local archaeologists (Do 1964; Do and Kim 1965; Sohn 1967, 1968). But, the discovery drew little attention until the excavation of Suyanggae and other sites in southern Korea in the 1980s and 1990s.

This history of research continues to influence archaeological understanding, which involves mistakes in descriptions and illustrations, as well as conventional misidentification. Under this circumstance, the present paper is particularly concerned with the following issues. First, the analysis will attempt to provide a useful database of Korean microblade cores for further research by examining all microblade cores reported from the Korean peninsula (Fig. 1). Because all materials, not just selected samples, are analyzed, the examination is expected to reveal a wide range of techniques used to produce microblades during the Upper Palaeolithic.

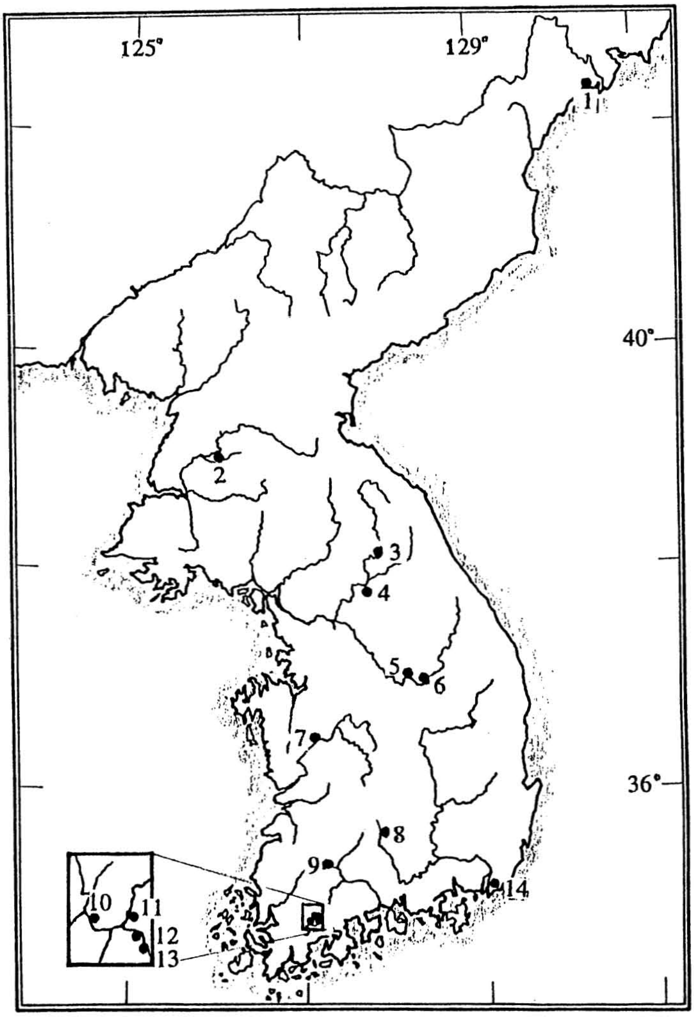

Fig. 2. Distribution of microlithic localities in the Korean peninsula: 1. Kulpo, 2. Mandal, 3. Sangmuryong, 4. Hahwagye, 5. Changnae, 6. Suyanggae, 7. Sokchang, 8. Imbul, 9. Okkwa, 10. Taejon, 11. Keumpyoung, 12. Kokcheon, 13. Juksan, 14. Jungdong.

Second, the issue of classification will be discussed by a critical evaluation of the current technological-typology of microblade cores put forth by Japanese and Chinese archaeologists. Current research and its limitations will be carefully discussed. My focus will emphasize reduction sequences, establishing a new analytical framework for examining microblade technology. The advantages of the framework will be addressed by applying it to technological variation in the microblade cores found in the Korean peninsula.

Finally, the analysis will survey other issues concerning microblade cores in Korea and adjacent northeast Asia. With the framework devised in the analysis, the examination will focus on spatial and/or temporal variability of microlithic assemblages in the Korean Upper Palaeolithic. Given that the issue requires extensive examination of various aspects including environmental and geological considerations, it will not be exhaustive. Rather, the study will place more emphasis on identifying current biases and developing future research orientations.

CURRENT RESEARCH AND LIMITATIONS

A Brief Research History of Microlithic Technology

Although the discovery of the so-called "wedge-shaped core" was reported as early as the 1930s, few microlithic assemblages in Mongolia have been examined satisfactorily, which makes comparison of finds between different areas of northeast Asia extremely difficult (see Chen and Wang 1989 : 147–148 for more research history).

Eastern Siberia has an extensive distribution of microlithic industries from the Lena River to the Pacific coast (Chard 1974; Kuznetsov 1995; Larichev et al. 1990, 1992). Technological and typological examinations are not conducted on a routine basis, and the bulk of the literature focuses on descriptions of major sites and chronological sequences of microlithic industries along with the preceding Middle Palaeolithic assemblages.

While the microlithic in China was studied in the context of Neolithic archaeology until the 1970s, excavations at Hutouliang, Xiachuan, and other major sites made it clear that this technology extends to the Upper Palaeolithic (Gai 1985). Since then, a number of microlithic localities have been excavated, uncovering tens of thousands of microblades and microblade cores. The distribution is limited to north China largely above 35° north latitude, with the highest density in the Songhua and Nen River Plain in northeastern China (Gai 1985; Kato 1992; see also Fig. 2).

Reconstruction of microblade technology has been one of the central issues of Chinese microlithic research. In an influential paper, An Zhimin (1978) divided microblade cores into five types: boat-shaped, weight-shaped, wedge-shaped, cylindrical, and conical, based on general morphology. While An's classification was criticized for ignoring technological variation, because of its descriptive convenience his morphological typology is still widely employed in the archaeological literature. Tang and Gai (1986) reconstructed three techniques, Hetao, Sanggan, and Hutouliang, and argued that the Hutouliang technique was the oldest. Aside from the problematic chronological assessment, however, technical variability cannot be encompassed by these three categories. Other reconstructions, the Yangyuan technique for example, have been added to the Tang and Gai system.

Japan also has a long history of microlithic research from excavations at Yadegawa and Fukui (Tozawa 1986). Based on the stratigraphy of Fukui, Aso (1965) proposed that microblade cores were developed with successive stages of semi-conical, conical, semi-boat-shaped, and boat-shaped forms. This chronology soon proved wrong when Chinese and Siberian data showed that conical cores persisted to the Neolithic (Obata 1987 : 3–4). In an influential work on northeast Asian prehistory, Chard (1974 : 49–50) argued that the "wedge-shaped core" represented "cultural influence from the north (Siberia-Hokkaido)" in northern Japan, whereas conical or cylindrical cores reflect local evolution out of the earlier blade tradition.

The distinction between boat-shaped and wedge-shaped cores is still widely employed in Japan and China (Kato 1992; Tachibana 1983). This is neither technologically nor morphologically warranted, but rather based on convention. The reliability of the archaeological knowledge regarding microlithic cultures depends heavily on the relevance and validity of technological typology. While Chinese criteria fail to encompass all potential variation, many proposed reconstructions in Japan are often too specific. There are few, if any, works that synthesize all of the techniques and types.

Regional studies add another level of complexity to an already overly differentiated typology full of isolated types. In other words, current microlithic research focuses on reconstructing techniques and establishing chronology based on technological criteria with no specific statement on the relationship between the two dimensions, technology and chronology.

Reconstructed Techniques and Types

A large number of manufacturing and/or morphological types have been proposed so far, especially by Japanese archaeologists. It is not possible to discuss all of them; ten of the more important techniques are summarized and compared in the text below, and eight of these are illustrated in Fig. 3 (Chen and Wang 1989; Kato and Tsurumaru 1980; Kimura 1983; Morlan 1976; Tachibana 1983; Tang and Gai 1986).

1. Yubetsu (Hetao) technique (Fig. 3*a*): The platform was prepared by a series detachments of long ski-shaped flake (ski-spall) from bifacially flaked blanks, entailing no further rejuvenation of the platform. The Yubetsu technique of Japan is almost identical to the Hetao technique of north China. Yubetsu cores, found in Hokkaido, are further divided into those belonging to the Shiradaki type with longitudinal rubbing traces, and those to the Satsukotsu type with no such trace.

2. Togeshita (Yangyuan) technique (Fig. 3*b*): Blanks were unifacially flaked resulting in D-shaped profiles. Longitudinal blows were delivered and usually stopped at a notch. The Togeshita technique is equivalent to the Yangyuan in China.

3. Oshoroko (Sanggan) technique (Fig. 3*c*): Small spalls were detached from the tip of the blank that was bifacially prepared. Successive rejuvenation of the platform is frequently observed in this technique, which is identical to the Sanggan technique in China.

4. Rankoshi technique (Fig. 3*d*): While blades were produced longitudinally, platform preparation was conducted along the short axis.

5. Saikai (Hutouliang) technique (Fig. 3*e*): The platform was shaped by transversal blows on the unifacially flaked (D-shaped in profile) blanks. This is compatible with Hutouliang cores in China. It is also called the Fukui type (Kato and Tsurumaru 1980) or technique (Tachibana 1983), which is comparable to the Xiachuan technique (Chen and Wang 1989).

6. Horoka technique (Fig. 3*f*): The platform was produced first by dividing the elongated blank in half to create a boat shape. Faces are formed by flaking directed from the platform.

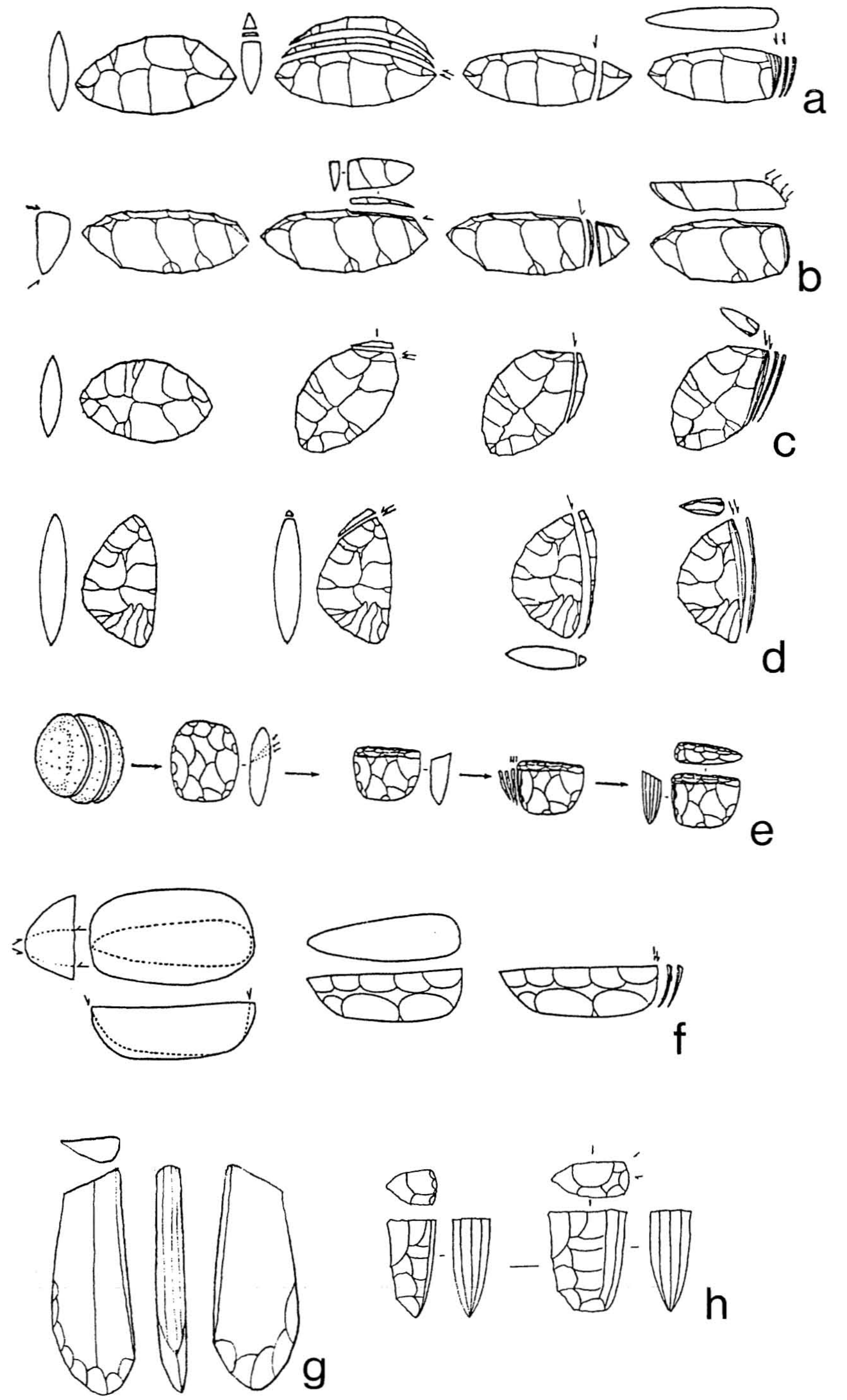

Fig. 3. Some reconstructed stages of microlithic techniques and types of microblade cores (for individual descriptions, refer to text section "Reconstructed Techniques and Types"). a: Yubetsu (Hetao); b: Togeshita (Yangyuan); c: Oshoroko (Sanggan); d: Rankoshi; e: Saikai (Xiachuan); f: Horoka; g: Hirosato; h: Yadegawa. (After Chen and Wang 1989; Kato and Tsurumaru 1980; Tang and Gai 1985.)

7. Hirosato type (Fig. 3*g*): Large blades were used as blanks from which to remove flakes.

8. Yadegawa technique (Fig. 3*h*): Little specific platform preparation was conducted on the flat surface of blanks and flakes. Morphologies are generally cylindrical and conical. This technique is believed to encompass such various types as Yadegawa, Yasumiba, and Moden cores. It is also called Nodake technique or type, especially in Kyushu (Tachibana 1983 : 66).

9. Funano technique: So-called "boat-shape" cores are attributed to the Funano technique, which has no flaking on the surface of a relatively thick blank, and the length and width of the platform are similar. Some cores have blade producing surfaces (flute after Morlan 1970, 1976) on both ends of the platform (Suzuki 1983; Tachibana 1983).

10. Unewara technique: The technique is simple and small cobbles serve as blanks with no further retouching on the surface. Preparation of the platform is often achieved with a single transverse blow. It has limited distribution in Kyushu, Japan (Tachibana 1983 : 66).

Limitations of the Current Technological Typology

The above ten categories do not sufficiently encompass all of the technological variation, and some scholars have added a few more types to the already complicated typology. Many regional variants, such as the Funano type in Oita, the Azehara type of Miyazaki, and the Setouchi type of Kyushu and Kinki, were added as new materials were discovered, and additional types will continue to be developed. The detailed experimental studies by Japanese and Chinese archaeologists certainly have many advantages. Analyses such as those pioneered by Gai and Tang (1982) comparing the Yangyuan technique with the Togeshita type reveal the diversity and development of microblade technology. Nevertheless, a few shortcomings can be attributed to the current fixed typology.

First, established types are often mistakenly treated independently of one another under the current typology. Given the manner in which types and techniques were established, subsequent examinations often add minor variations or refine existing types. Because it is overly specific with little attention to the relationship between the types, the current typology does not effectively accommodate the full range of variation or the relationships among the reconstructed techniques. Only a portion of the full spectrum of technological variation is embraced.

Second, while those specimens compatible with the established typology draw central attention, other objects are simply treated as supplementary or "noise." While the techniques might be valid in some cases, a number of other examples remain ambiguous with respect to the typology. Only specimens compatible with established types are identified and those casual or unfinished materials are often excluded from the study. We cannot rule out the possibility that many microblade cores were produced casually, which would not be covered by the fixed typology, as suggested here by the Korean data.

Third, there has been little consideration as various terms of different dimensions are often used interchangeably. In other words, such morphological names as "wedge-shaped," "boat-shaped," "cylindrical," and "conical" are intermingled with technological criteria without any precise definition provided. While many distinguish wedge-shaped cores from boat-shaped cores, it is common to use the term "wedge-shape cores" to represent various kinds of microblade cores. This confusion is furthered by the distinction between technique and type of cores: while Togeshita technique, for example, results in Togeshita type cores, Saikai technique has a different name, Fukui type. Based on the consideration of blank preparation (see below), the current distinction between wedge-shaped and boat-shaped cores is insufficient to account for the full range of technical variability. Although the terms may be used for the sake of descriptive convenience, they are not appropriate for analytic purposes.

This may explain why there have been few syntheses dealing with microlithic data from the Japanese archipelago, or northeast Asia. A broad scale comparison, which is essential for the study of microlithic technology in northeast Asia, is hindered by this situation in which different terms are used to indicate similar techniques. Lack of common (or communicative) typology is the main reason why there has been no detailed comparative examination of microblade cores, let alone whole lithic assemblages (Yi and Clark 1985). The typical investigation of a microblade technology and the microlithic involves sketches of major sites for which the presence of a named technique is reported. Small sites with few stone artifacts are likely to be underrepresented.

Most studies deal with microblade cores as final products. The purpose of the technology is to produce microblades, not microblade cores, which are waste products from the perspective of lithic analysis. It is not possible to reconstruct the full range of technological variability only from the final form of waste materials.

Although typological schemes previously presented by Chinese, Korean, and Japanese archaeologists have all involved some kind of reconstruction of reduction sequence, they are focused on final, exhausted cores. In examining the technology of microblade production one must include those materials that usually do not draw much attention in the archaeological literature. This research tendency reflects the culture history paradigm dominant in the archaeology of northeast Asia in which the establishment of index fossils is the basis for the description of the archaeological record.

ANALYSIS OF MICROBLADE TECHNOLOGY

Reduction Sequence and Classification of Microlithic Technology

Methodological Discussion: —Most information concerning techniques of lithic manufacture is drawn from cores. With regard to microlithic industries, it may be difficult to analyze the product of microblade cores, that is, microblades. Microblade technology can be examined on the basis of cores, since they are basically residuals after their history of preparation, blade production, and/or rejuvenation. It is not possible, however, to reconstruct every stage of this history. Blanks might have been severely altered by subsequent flaking obliterating evidence of the original form. Early striking platforms might have been removed by later flaking. Also, the procedure might have been repeated, and a platform could have been manufactured before the faces had been prepared, especially in the case of the Horoka technique and the Denbigh technique in North America (Chen and Wang 1989; Morlan 1970, 1976).

Furthermore, cores might have been discarded before they were used in producing microblades as has been observed in the Korean materials. In those cases, however, such materials must be treated as cores, as long as we are examining microblade manufacturing technology. These unfinished microblade cores do exist, indicating that fixed typological schemes with the array of isolated types have significant drawbacks.

In his detailed analysis of Mousterian lithic technology, Kuhn (1995) discusses two broadly different traditions for studying lithic technology. First, archaeologists with their main intellectual origins in French Palaeolithic research tend to focus on reduction sequences, or *chaînes opératoires*, rather than final products, with emphasis placed on technological reconstruction including refitting and replication processes. Second, analysts from the American tradition are interested in the product itself as the central theme, often involved in quantitative analyses of flakes, tools, and cores.

Given the difficulties in analyzing materials such as flakes rather than cores, it is expected that an analysis of cores based on the concept of reduction sequences will be most appropriate in revealing the full range of technical diversity. A distinction between earlier and later stages of lithic manufacture is an important facet in examining various aspects of technology and such related issues of resource procurement and tool use (Teltser 1991 : 369). The adoption of the reduction process as a basic analytical concept does not mean wholesale rejection of the current typology. Under the general framework of the culture history paradigm, the current typology does not encompass the full variation of microblade technology.

A full account of lithic reduction sequences will contain two components: the sequences involved in making a particular type of tool, and the sequential relationship among types of artifacts. With regard to the latter, a systematic examination of microblade production with microblade cores must be supplemented by the study of their position and role in the lithic reduction sequence in association with other kinds of stone tools such as scrapers or flakes in general constituting the assemblage as a whole. The present analysis focuses on the first aspect of reduction sequence, while briefly addressing the issue of reduction process between cores and other stone tools.

While most current archaeological investigations place heavier emphasis on a qualitative technological reconstruction of microblade techniques, quantification also can serve descriptive and supplementary purposes. The present analysis starts with qualitative steps of classification by distinguishing three major technological procedures (blank formation, platform preparation, and blade production), and then explores some implications suggested by quantitative analyses. However, the classification was obtained not from quantification, but from analytical criteria based on the presumption that the types presented are imposed by the analyst for the purpose of examining variability, not inherent in the data (Dunnell 1971).

Since reports of microblade cores from the Korean peninsula often do not contain descriptive statistics, a few numerical measurements of microblade cores were taken not directly from artifacts but from illustrations. Hahwagye, Okkwa, and Taejon materials and some other cases are exceptions since the measurements are in the reports. Some cases often lack adequate descriptions and illustrations.

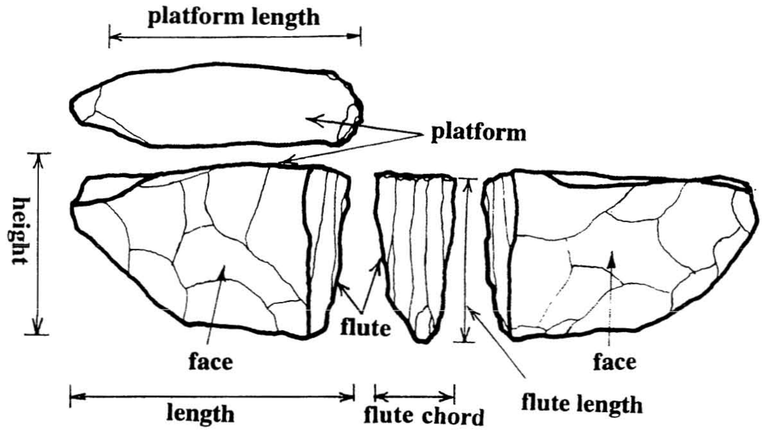

Fig. 4. Terminology of a microblade core. (After Morlan 1976.)

As a result, this quantification has some inevitable errors. Yet, these errors do not diminish the need to examine general technological variation, since the primary criteria are assigned qualitatively while quantification is only employed for descriptive purposes.

Classification of Microlithic Technology: —Based on the concept of reduction sequences and accepting many useful observations presented by earlier researchers for defining microblade making techniques (Fig. 4), three different stages can be recognized in the manufacturing microblades: blank formation, striking platform preparation, and blade detachment. Such supplementary processes as heat treatment (Flenniken 1987) and abrasion (Kato and Tsurumaru 1980) may be performed, and the three stages may be repeated to rejuvenate the core. In some cases, for example, the platform was prepared before faces were formed (see the proposed reconstruction of Horoka technique and type III cores below). This may be the crucial characteristic that distinguishes "conical" cores from other "wedge-shaped" cores (see Kobayashi 1970). The three stages serve as the basic units of microlithic technology, and we can identify its diversity by creating types at each dimension, that is, technical stage, and their sequential relationship (see Table 1).

TABLE 1. CLASSIFICATORY FRAMEWORK OF MICROBLADE CORES (SEE FIG. 3)

BLANK FORMATION	PLATFORM PREPARATION	BLADE PRODUCTION
Bifacial, elongated (I)	Longitudinal blows (A)	Location
Unifacial, irregular (II)	Transversal blows detaching large spall and subsequent trimming (B)	Confined to edge (a)
Prismatic, or conical (III)		Ambi-polar (b)
Large blade/flake (IV)	No preparation (C)	Circumferential (c)
		Angle
		Perpendicular (a, b, c)
		Acute (a1, b1, c1)

Aside from the acquisition of raw materials, the first step in blade production, or any other stone-tool manufacture, is blank (or blank face, after Morlan [1976]) preparation. Given the sophistication of microblade technology, this first step of lithic reduction sequence may result in crucial differences in the final product. A distinction between so-called wedge- or boat-shaped cores and conical cores is widely accepted. Although the final forms display easily discernible differences, it is unclear that such differences existed in the production of blanks. The present analysis will employ the distinction (as specified by blank types I and III below), considering the difference of blank profile (oval vs. circular). A closer look at the variation of wedge-shaped or boat-shaped cores will lead to further partitioning. We can distinguish two criteria (distinction between types I and II below) in terms of degrees of flaking on blanks, which will be regarded as important characteristics in studying the variation of microblade technology throughout the analysis. In addition, cases in which long blades or suitable flakes were used as blanks (with typically microblade producing surface along the long edge) will be classified into blank type IV.

The four approaches to preparing blanks are summarized as follows: (I) bifacially flaked blanks of an elongated oval shape and with lenticular view of cross section; (II) blanks unifacially or roughly flaked, of varying shapes, which may retain some cortex on the surface; (III) blanks semicircular in plan view and conical in side view; and (IV) large blades or flakes used as blanks rather than elaborated core-specific materials (see Fig. 4).

There are difficulties in identifying blank types because the original form may be lost by subsequent blade production processes. While platform and previous blade production surfaces are altered by subsequent flaking and rejuvenation, the criteria for blanks employed here are technological and morphological attributes, such as degree of flaking and profile, which would retain their characteristics subsequently. Blank types may be the most important feature determining variation of microblade technology.

Because these types (except type III) represent the first stage of microblade technology (Andrefsky 1987: 30–33; Kobayashi 1970), we can examine the reduction step in terms of the relationship between cores and other stone artifacts. Type I blanks with their bifacial flaking represent the most elaborated form. Some blanks bifacially flaked and retouched along the edge could have been used for tools, for example, as cutting tools or scrapers. Bifacial points and cores may have been interchangeably manufactured.

There are fewer indications of the reduction step for type II blanks with other tool types. Some blanks may have been derived from the process of making other tools, given that there are quite a few large amorphous flakes used as blanks, and some have minor retouching along the edge. Type IV blanks made on large blades may display a close relationship with burin technology.

The current typology places greater emphasis on platform preparation than the other technological stages. This analysis adopts distinctions based primarily on the direction in preparing flaking for making striking platforms. The following approaches to platform preparation may have been used interchangeably in some cases.

Two general approaches to preparing platforms are observed in terms of the direction of flaking: (A) longitudinal flaking from the blade producing edge, and (B) transverse flaking or the detachment of large spalls often associated with multidirectional retouching. In addition, type C may be applied to cases in which no special platform preparation occurred. Type A can be further subdivided: (A1) detaching long and narrow flakes called ski-spalls to make a flat platform along the long margin; (A2) burin blow or flaking stopped (often by a notch) in the middle of the platform; and (A3) hard struck to divide the blank in half (and typically followed by trimming of faces from the direction of platform) (Fig. 4).

Less attention has been paid to the process of blade detachment. The main criterion used in the distinction of blade detachment is the location of blade production: (a) blade production is confined to the edge of the core; (b) both ends of the core were used for blade production (ambi-polar); (c) blade detachments surround the platform (circumferential). The attribute of location of blade production may be significant in identifying the sequential relationship between wedge-shaped cores and conical cores. That is, type (b) represents an intensive form of blade production for wedge-shaped cores, and (c) may be viewed as an extreme of type (b).

Another attribute can be added in terms of flaking angle indicated by the intersection of the plane of the platform and the blade producing surface (flute). Two categories are observed: when blades were detached with less than 60 percent (acute angle blade production) of platform and blade production surface cores will be assigned to (a1), (b1), and (c1). When blade production took place at close to 90 percent of the platform and blade production surface, no further specification will be made, that is, they will be assigned to (a), (b), and (c). Along with the location of blade production, the attribute of blade producing angle is an important characteristic in examining degree of intensity and exhaustion of microblade cores (see Fig. 4).

Paradigmatic classification can be applied when the three stages can be specified as three dimensions and classes can be generated by intersecting the dimensions and attributes. With the combination of variables and distinctions proposed above, we can generate thirty-six classes ($4 \times 3 \times 3$), and the number of the class will substantially increase as we include one more dimension, angle of blade production ($4 \times 3 \times 3 \times 2 = 72$). As is often the case with paradigmatic classifications, many classes do not contain any cases, such as type IVAb. Largely involved in "identification," that is, assigning individual objects into established types, the current typology is a "key" after Dunnell's (1971) discussion.

This approach to generating classes also provides a useful tool for comparison with established types, and the greater inclusiveness of the present analysis is well demonstrated by the comparison. The Yubetsu or the Hetao technique may represent a combination of type I or type II with type A1 platforms. The Horoka technique is a combination of type A3 platform fabrications and type I blanks. The Saikai or Hutouliang technique is compatible with class IIB, but it may also contain some specimens that may be classified as class IB. The Togeshita or Yangyuan technique can be identified as a combination of type II blank and type A2 platform preparation. Some samples of category IV blanks may be called Oshoroko or Sanggan technique, while the Rankoshi technique also involves type IV blanks. Microblade cores involving type IV blanks include the Hirosato technique, while the Yadegawa technique involves blanks of type III.

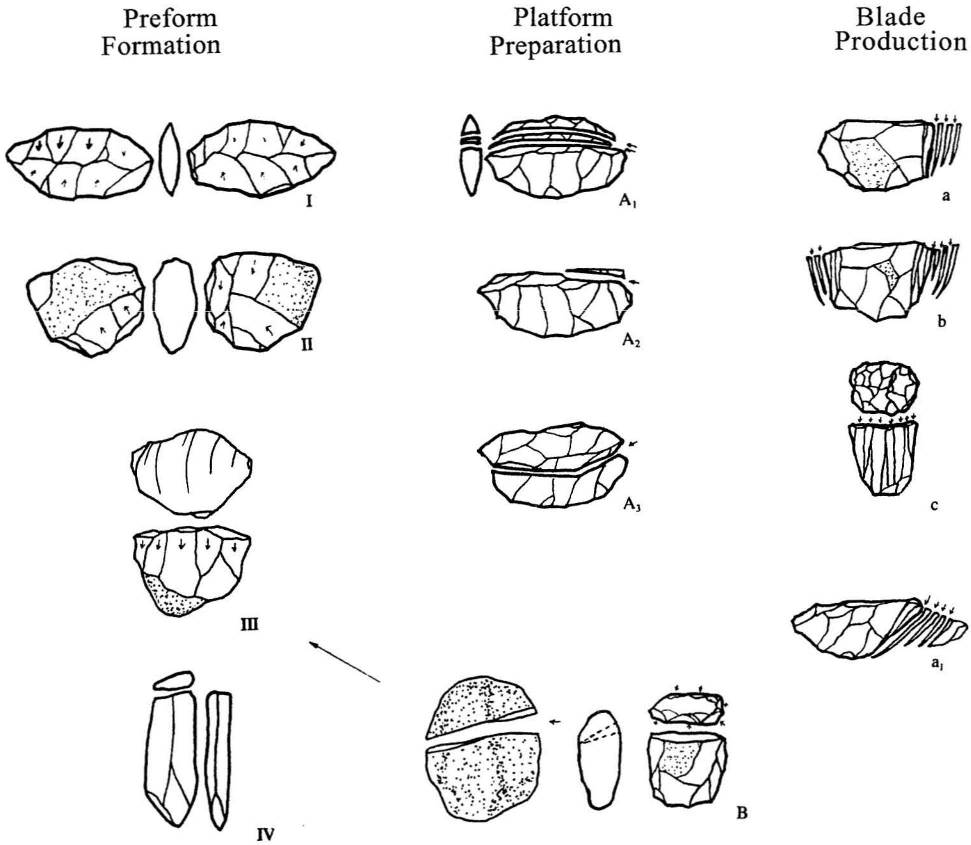

Fig. 5. A schematic illustration of the reduction sequence of microblade technology. (Based on Kato and Tsurumaru 1980; Kobayashi 1970; numbers and letters refer to Table 1.)

Discussion of Korean Microblade Cores

Blank Formation: —The general morphology of microblade cores is significantly influenced by the first stage of the reduction process, implying that blank production is not only the first step toward microblade detachment but the most crucial step that significantly affects subsequent procedures. While there may be cases in which it is difficult to distinguish among blanks of types I or II, in most cases of Korean microblade cores the two types are distinctive in terms of the degree of bifacial flaking. Type I is typical in the Suyanggae sample. Blanks are relatively large and are often twice as long as they are high (Fig. 5), and flaking was conducted on the whole surface. Blanks of type I are bifacially flaked into a form resembling a bifacial point with a convex lens cross section.

Many microblade cores found in the Korean peninsula can be assigned to type II blanks. These are often smaller than those of type I, and lengths and heights are more or less equal in many cases. Some were unifacially flaked and others have no apparent trace of flaking on the surface. Although specimens were also bifacially flaked, their elaboration is much less than that of type I blanks. Flakes may have been used as blanks, in which case more preparation was required to produce platforms suitable for blade production.

Type III blanks are known as conical and cylindrical, or prismatic cores. The most notable characteristic of this type is that the platform is produced first with subsequent working on the side, which is a significant technological difference from type I and II cores (see Fig. 4). Thus, blade production may exist only in a limited area or on both ends of the core, but typically around the whole periphery of the platform. The platform is prepared by flaking a large spall from "a cobble or tablet of stone" (Andrefsky 1987 : 30). It is believed that a significant amount of trimming was required on the platform when detaching the blade, which is comparable to the platform produced by a type B transversal blow and subsequent retouch. Some Japanese archaeologists suggest that conical cores (the Notake type) and the technique of "large blade culture" share the characteristic of producing blades longitudinally (Tachibana 1983).

Type IV blanks do not have a coherent set of features that distinguish them from other types. Large blades and elongated flakes were used as blanks and blades were produced longitudinally.

Platform Preparation: —The issue of platform preparation draws more attention in the current typology than that of blank production. In many cases, however, it is extremely difficult to determine how the striking platform was formed, given unsatisfactory illustrations in archaeological reports, which often do not contain a view of the platform. In the present analysis, no determination was attempted unless sufficient information was available. The number of cores for which the mode of platform preparation can be reliably determined is about thirty.

Since blank type III cores do not require a platform, these are not associated with platform type A. Platform production, similar to type B, is performed before the blank formation. Six type I and six type II cores are associated with type A1 platforms. There are five type A2 platforms observed, one from Sokchang (no. 59), and the other four from Suyanggae. These platforms are typically associated with type I blanks, except for one from Suyanggae (no. 42), which is a type II blank.

There are six cases of type B platforms, one from Sangmuryong, two from Suyanggae, two from Sokchang, and one from Imbul. Most platforms made by transversal blows are combined with type II blanks, with two exceptions from Sokchang (no. 62). Only one specimen from Suyanggae was made with a platform preparation technique categorized as type A3. Some four cores from Mandal and Suyanggae have no trace of intentional platform preparation (type C). In these cases, the surface of natural cortex served as the platform for blade production.

Blade Production: —The final stage of blade production has been underrepresented in traditional examinations. Blank formation and platform production represent no more than the preparation process of blade production. While in most cases blade production took place at an edge of the core (single-fluted), some show that it occurred at both edges (double-fluted, after Morlan [1970]). In a typical sequence of making microblades from conical cores, transverse flaking is followed by the development of prismatic blanks, and then detachment of blades perpendicular to the core follows. Type III can generally possess a platform surrounded by blade detachments (type c), but it is not uncommon to find the opposite, that

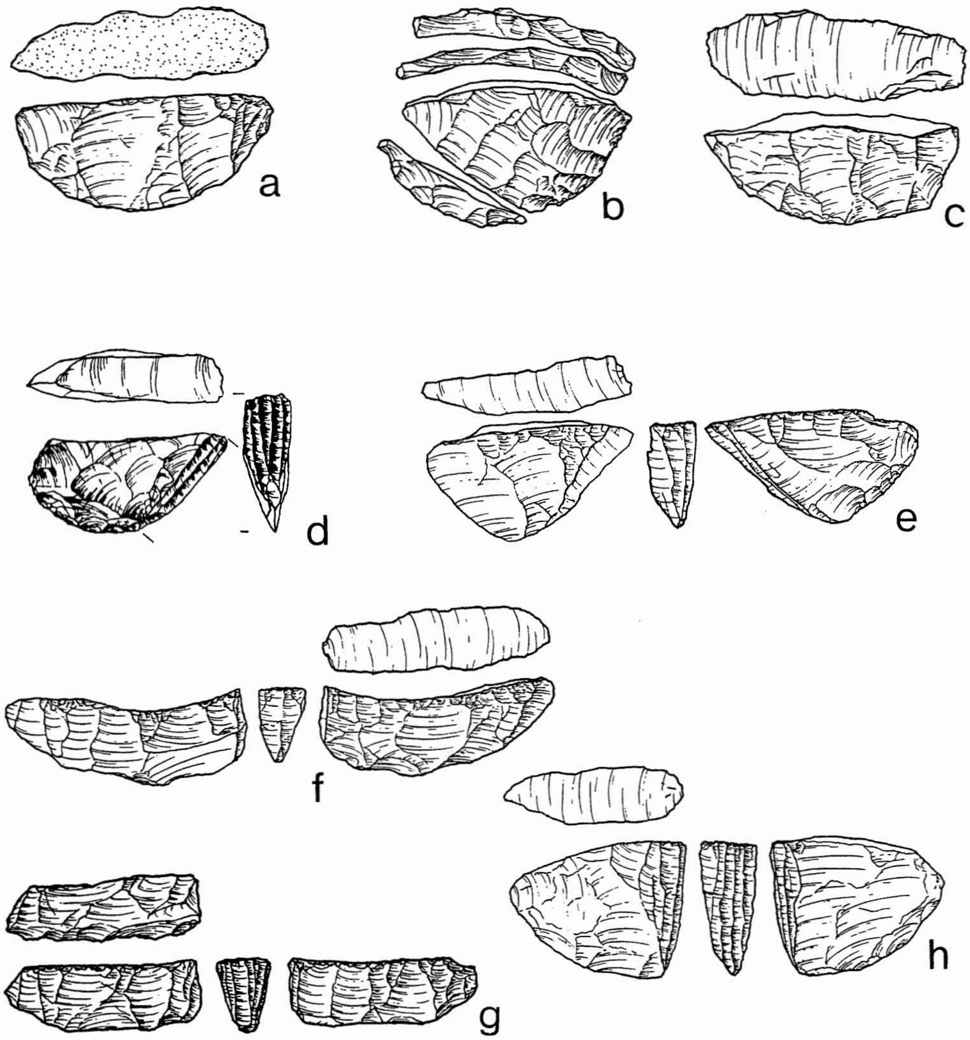

Fig. 6. Microblade cores found in Korea (blank type I). a: Suyanggae (no. 36); b: Suyanggae (no. 44); c: Sokchang (no. 60); d: Suyanggae (no. 33); e: Suyanggae (no. 45); f: Suyanggae (no. 46); g: Sokchang (no. 62); h: Taejon (no. 79). (Redrawn based on original reports; size variable; numbers refer to Table 2.)

is, blades confined to a certain area (type a, no. 6 from Mandal in Fig. 6 for example). Along with blade-producing angle, the location of blade production may reflect the degree to which a core was exhausted.

The majority of cores have angles between the platform and blade detachment surface (flute, after Morlan [1976]) of between 70 and 90 percent (fifty-three out of sixty-seven cases). While it is expected that this angle will decrease as additional blades are detached, fourteen cores apparently have angles formed by platform plane and flute that are much smaller than the right angle, that is, acute angle blade detachment. If we apply this criterion to type III blanks, variation of blade angle would be a good indicator in distinguishing conical cores, which have an acute angle, from cylindrical cores.

While it is possible to link the degree of exhaustion of a core and the acuteness of blade production, an unfinished specimen from Suyanggae (no. 44, Fig. 5), which was refitted with two ski-spalls and one flake (*lame à crête*), makes this difficult. Acute angle blade production may represent a different technological aspect. Blade production at an acute angle is not limited to certain types of blanks. Six specimens of type I blanks, five examples of type II blanks, and three samples of type IV blanks have acute angle blade production. Type I cores with acute angle blade production are from Suyanggae (4) and Sokchang (2), and all II and IV types are found at Hahwagye.

Figure 7 shows the relationship between platform lengths and flute lengths. These two attributes most efficiently demonstrate the technological aspects as well as the size of microblade cores. The data for some sixty microblade cores show no relationship between the two attributes ($r = 0.111$, $r^2 = 0.012$), indicating that the blade length, as measured by the length of microblade producing surface on the core, is not correlated with the size (or length) of the platform.

Examining the relationship in terms of blank types, however, provides somewhat different results. There is a positive relationship between the size of the platform and the blade (see Fig. 9). Although the correlations are very weak, especially for types I and IV, cores with larger (or longer) platforms tend to have longer blades, which is also reflected in the size of cores themselves. The exception is the type of type IV blanks. In this case, the size of the blade negatively correlates with that of the platform, but this may be due to the small sample size. If we take out two outliers of type I with exceptionally long flutes, there is virtually no relationship between the size of platform and that of blade.

Cores of each of the four different types of blanks grouped together. While only a slight difference can be observed in terms of blade length (blades from type III blanks tend to the largest, followed by types IV, II, and I), the size of the platform is the main determinant of these groupings. Platforms with type IV blanks are the smallest followed by those with type III and II blanks, while type I blanks are likely to have the largest platforms. Type II blanks generally represent the average size of cores, and their distribution in the graph is rather concentrated, if we exclude the unusually "big" microblade core found at Mandal (no. 1). This may indicate that microblade cores of type II blanks were the most general during the late Palaeolithic of Korea, which is also supported by distribution over the entire peninsula.

MICROLITHIC ASSEMBLAGES IN KOREA

The proposed framework for investigating microblade technology provides a basis for a discussion of the final stage of the Korean Upper Palaeolithic. Microblade cores have been recovered from fourteen localities, and the distribution is widespread throughout the peninsula (Fig. 1; Table 2). Most Upper Palaeolithic localities yielded microblade cores, although some localities such as Changnae have few indications of microlithic industries. Microblade cores and associated assemblages from eleven localities will be discussed here, since there are no details available about the finds at Kulpo, Changnae, and Jungdong.

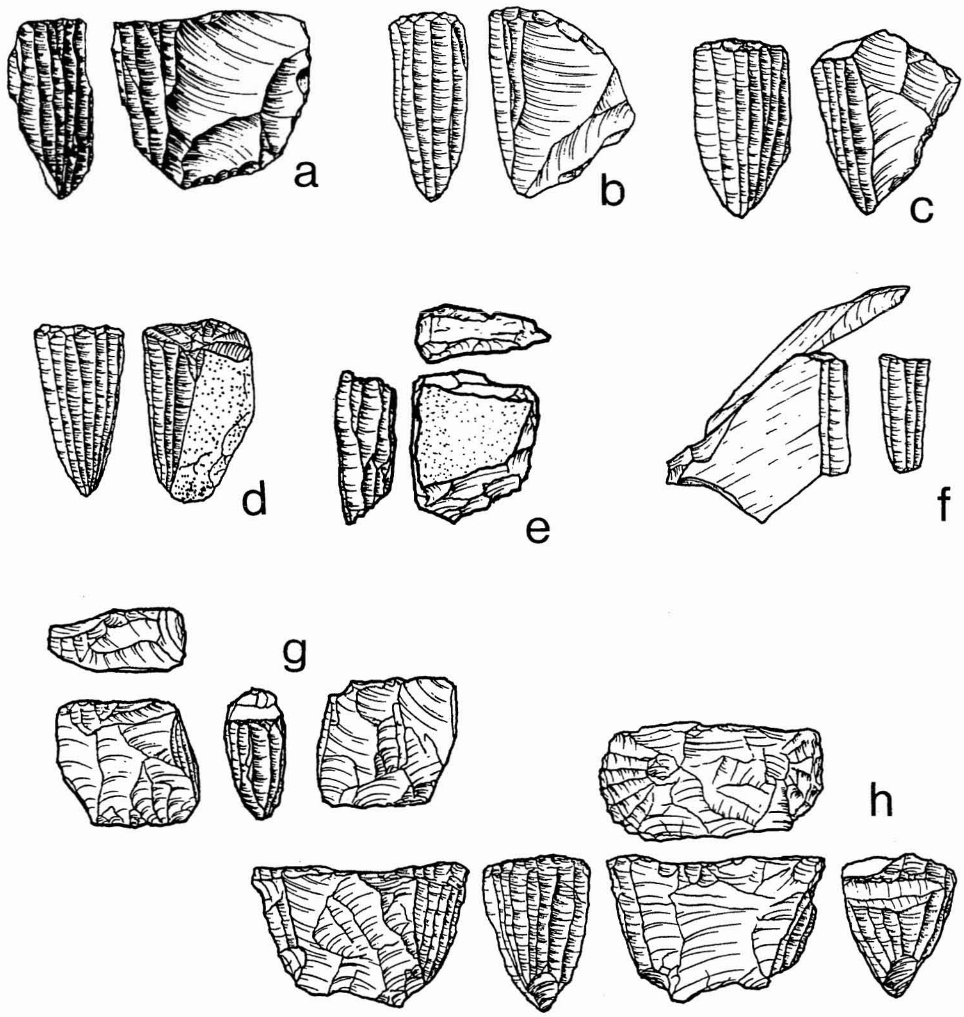

Fig. 7. Microblade cores in Korea (blank type II and III). a: Mandal (no. 5); b: Mandal (no. 2); c: Mandal (no. 3); d: Mandal (no. 6); e: Sokchang (no. 66); f: Okkwa (no. 71); g: Imbul (no. 82); h: Sangmuryong (no. 9). (Redrawn based on original reports; size variable; numbers refer to Table 2.)

Few studies have been devoted to the various issues of the final stage of the Palaeolithic in Korea. Only the Mandal site is found in a cave, and the fossil record is very scarce in Korea. Consequently, it is difficult to address such issues as the subsistence of the people who made microlithic tools. Chronology has been the main focus, yet no agreement has been reached. The main reason for the lack of stable chronology can be attributed to the rarity of microlithic localities with good stratigraphy.

Mandal

The limestone cave deposit located 40 km east of Pyongyang has yielded thirteen stone artifacts, including seven blade cores. One quartzite object may not be

Table 2. Microblade cores found in the Korean Peninsula

	Site	Height (mm)	Length (mm)	Thickness (mm)	Platform Length (mm)	Platform Width (mm)	Minimum No. of Blades	Flute Length	Raw Material	Class	Literature
1	Mandal	92.3	43	37.6	29	19.5	5+	73	Quartzite	II C a	S. Kim et al. 1985; Seo 1987
2	Mandal	43	24	12.4	30	11	7+	41.5	Obsidian	II A a	S. Kim et al. 1985
3	Mandal	36.5	29.5	19.5	29.5	19	8+	36.5	Obsidian	IIa	S. Kim et al. 1985
4	Mandal	35.5					6+		Obsidian	II	S. Kim et al. 1985
5	Mandal	34.5	39	17.3	34.5	14.8	5+	29	Obsidian	IIa	S. Kim et al. 1985
6	Mandal	26.5	16.5	13.7	16.5	14	7+	26	Obsidian	II C a	S. Kim et al. 1985
7	Mandal						6+		Obsidian	III(?)	S. Kim et al. 1985
8	Kulpo								Quartz		Do & Kim 1965; Y. Kim 1984
9	Sangmuryong	29	45	23	45	23	6+, 5+	44.5		II B b	Choe 1989
10	Sangmuryong	66	33	23	29.5		2+	60.5		III (?) a	Choe 1989
11	Hahwagye	39	44	35	37	33		38	Hornfels (?)	IIIa	Choe et al. 1992
12	Hahwagye	13	19	11	18			19	Obsidian	IIa1	Choe et al. 1992
13	Hahwagye	14	28	15			6+	22	Obsidian	IIa1	Choe et al. 1992
14	Hahwagye	43.4	10.5	8.6	10		4+	40	Obsidian	IVa	Choe et al. 1992
15	Hahwagye	29	15	9	14		16+	29	Obsidian	IVa	Choe et al. 1992
16	Hahwagye	14.7	22.4	7.7					Obsidian		Choe et al. 1992
17	Hahwagye	25.7	20.5	9			10+	23	Obsidian	IIb	Choe et al. 1992
18	Hahwagye	23.4	28.5	7	13		5+	18	Obsidian	IIa	Choe et al. 1992
19	Hahwagye	16.6	23	11	21		8+	18	Obsidian	IIa1	Choe et al. 1992
20	Hahwagye	24	19	10	16		20+	22	Obsidian	IVa	Choe et al. 1992
21	Hahwagye	30	9.5	10	12		4+	27	Obsidian	IVa1	Choe et al. 1992
22	Hahwagye	48	13.7	8	8		4+	44	Obsidian	IVa1	Choe et al. 1992
23	Hahwagye	10	20	8			6+	17	Obsidian	IIa1	Choe et al. 1992
24	Hahwagye	15	25.6	10	25.6	13	4+	18	Obsidian	IIa1	Choe et al. 1992
25	Hahwagye	24	16	13	13		10+	22	Obsidian	III(?)	Choe et al. 1992
26	Hahwagye	21.3	6.7	6.3	6.2		14+	18.7	Obsidian	IVa1	Choe et al. 1992
27	Hahwagye	17	18.7	8.3			8+	15	Obsidian	IIa	Choe et al. 1992
28	Hahwagye	22	34	25			7+	25	Quartz	IIa	Choe et al. 1992
29	Hahwagye	25	14.8	13	13				Quartz		Choe et al. 1992

30	Suyanggae	16.2	40.3	10.2		8.6	6+	16.2	Shale	Ia	Lee 1984
31	Suyanggae	24.7	35	10.4	24	8	3+	24.7		II B a	Lee 1985
32	Suyanggae	24.9	29.8	11.2	24.8	10.4	5+, 6+	22		II A(?) b	Lee 1985
33	Suyanggae	28.2	58.5	15.2	51	15.2	5+	30.1	S shale	I A1 a1	Lee 1985
34	Suyanggae	28.5	75	8	55.7	8	4+	18		I A(?) a	Lee 1985
35	Suyanggae	16.5	25	12.5	21	12.5	6+	15	S shale	II C a	Lee 1989
36	Suyanggae	34.5	70.5	22.5	69	21	2+	20	S shale	I C a	Lee 1989
37	Suyanggae	18.5	21	12.3	21	12.3	7+	22	Obsidian	II a	Lee 1989
38	Suyanggae	22	67	20	66.5	20	4+	9	S shale	I A2 a	Lee 1989
39	Suyanggae	22	53	23	52.5	23	5+	26	S shale	I A2 a	Lee 1989
40	Suyanggae	35	48.5	11			3+	35	S shale	I	Lee 1989
41	Suyanggae	31	54	15	41.2		0	19	S shale	I	Lee 1989
42	Suyanggae	25.5	35.7	13.6	35.7	13.6	4+	27	S shale	II A2 a	Lee 1989
43	Suyanggae	17.5	51.5	11	51.5	11	4+	22	S shale	I A1 a	Lee 1989
44	Suyanggae	41	71	17	57.5	17	2(?)+	16	Shale	I A1 a1	Lee 1989
45	Suyanggae	36	66	17	64.5	15.5	6+	52	S shale	I A1 a1	Lee 1989
46	Suyanggae	22	71	20	71	20	3+	22	S shale	I A3 a	Lee 1989
47	Suyanggae	23	41	10.5	40.5	10.5		22.5	S shale	I A2 a	Lee 1989
48	Suyanggae	24.5	43	14	43	10.5	6	22	S shale	IIa	Lee 1989
49	Suyanggae	18.5	38.5	14	38.5	14	2+, 4+	21	S shale	IIa	Lee 1989
50	Suyanggae	48	63	19	63		0	41	Shale	I A1 a1	Lee 1989
51	Suyanggae	23	27	10.5	21	9.8	5+	23		II Ba	Lee 1984, 1989
52	Suyanggae	20	74	20	71.5	20	4+	15	S shale	Ia	Lee 1989
53	Suyanggae	18	27	8	25	6.7	5+	20	S shale	II A1a	Lee 1984, 1989
54	Suyanggae	25.3	35.7	13.6	26.4	12.5	6+	25.3	S shale	II A1a	Lee 1984, 1989
55	Suyanggae	23.5	45.9	16.5	43.5					II	Lee 1989
56	Suyanggae	26	41	16	41	16	6+	25	S shale	Ia	Lee 1989
57	Sockchang	32	14	12	13.5	13	3+	29.5		IV	Sohn 1967
58	Sockchang	21	13	12.5	12.4		5+			III	Sohn 1967
59	Sockchang	35	63.5	20	63	19.7	4+	25		I A2a1	Sohn 1968
60	Sockchang	30.3	71	23.7	71	23.7			Porphyry	I A1a1	Sohn 1968
61	Sockchang	23.8	24.6	13.8	24.6	11	6+	23.8	Porphyry	II A1a	Sohn 1973*a*
62	Sockchang	12	33.2	9.3	31.9	8.9	8+	11.9		I Ba	Sohn 1973*a*
63	Sockchang	44.1	26.4	13.8	8	10.7	4+	44.1		IVa	Sohn 1973*a*

(*Continues*)

TABLE 2. *Continued.*

	SITE	HEIGHT (MM)	LENGTH (MM)	THICKNESS (MM)	PLATFORM LENGTH (MM)	PLATFORM WIDTH (MM)	MINIMUM NO. OF BLADES	FLUTE LENGTH	RAW MATERIAL	CLASS	LITERATURE
64	Sockchang	39	15		14.5		5+	33		IV(?)	Sohn 1973*b*
65	Sockchang	38	14.5		14		8+	36		IV	Sohn 1973*b*
66	Sockchang	33	29	12	29	12	6+	33		IIa	Sohn 1973*b*
67	Sockchang									IIBa	Sohn et al. 1994
68	Sockchang									IIa	Sohn et al. 1994
69	Sockchang									IIa	Sohn et al. 1994
70	Songjeon, Okkwa	23.6	25.1	10.4	23.6	10.4	15+	14.6	Porphyry	IIA1a	Yi et al. 1990*a*
71	Songjeon, Okkwa	18.8	32.1	6.8	32	6.8	5+	17.9	Tuff	IIA1a	Yi et al. 1990*a*
72	Songjeon, Okkwa	36.3		29.2	39.6	27.6	3+	22	Tuff		Yi et al. 1990*a*
73	Jusan, Okkwa	6.9	15.5	13.6	13.4	13.2	9+	?	Tuff		Yi et al. 1990*a*
74	Keumpyoung	34	16.1	9.1	6		18+	29	Tuff	IIIa	Lim & Yi 1988
75	Juksan								Tuff	IIa	Yi et al. 1990*b*
76	Taejon	42.9	87.1	20		14.3			Tuff	Ia	Lee & Yun 1992*b*
77	Taejon	34	24	10	24	10.5	5+	29	Porphyry	IIa	Lee 1989
78	Taejon	24	56	16	56	16	5+	20.2	Porphyry	I A1a	Lee & Yun 1992*b*
79	Kokcheon	37.5	50	15.8	50	15.6	7+	38.5		IIa	Lee 1989
80	Kokcheon	19	38	17	38	17	2+, 1+	24	Quartz	IIb	Lee 1988*b*
81	Imbul	16	18			17		14		II A1a	Lee & Yun 1996
82	Imbul	35	33	15.5	32.5	14.5	5+	24	Tuff	IIBa	C. An 1988

S shale: siliceous shale.
Measurements conducted on the drawing may not represent precise Values.
Determination of raw materials are based on reports and may need re-identification (especially for the tuff).

included in a microblade core in the strict sense, because the blade is 73.0 mm in length and 9.2 mm in width (no. 1 in Table 2). However, it was included in this examination because it displays a typical microblade technology (class IICa). In addition, given the size, it may be suggestive of the range of technological variation and of the limits imposed by the raw materials. It is believed that the natural cortex of the quartzite was used as platform in the blade production (Seo 1987), although no illustration was provided in the original report.

The other six microblade cores are all made of obsidian. According to Obata (1987), both longitudinal and transversal blows were employed in preparing platforms, but only two cases have platforms illustrated in the original report, artifact no. 2 (type A) and no. 6 (type C). Among six obsidian microblade cores, two may be assigned to blanks of type III, while the remaining four cores are of type II blanks.

Stone artifacts were uncovered in the lower part of the 1.6–2 m thick deposit where limestone is mixed with the remains of a human skull, bone tools, and animal bones, although no illustration of stratigraphy is available in the original report (Kim et al. 1985). The importance of the locality lies in the fact that it is the only cave site that has yielded microliths along with perishable materials. While many Pleistocene cave deposits are known in the peninsula, the majority are assigned to earlier periods, while some seemingly late Pleistocene cave localities lack indications of microlithic industry or human occupation.

Hahwagye and Sangmuryong

The Hahwagye site is located on the Pleistocene terrace of the Hongcheon River valley and was excavated in the early 1990s. Some 7000 stone artifacts from the site include about 6000 made of quartz and 834 of obsidian (Choe 1993; Choe et al. 1992); these represent quartz choppers, scrapers, end-scrapers, burins, awls, and large blades, and obsidian microblades and cores. The artifacts were collected on the surface and unearthed from the top portion of the Pleistocene deposits.

Although 515 microblades were found, only nineteen microblade cores were identified, of which sixteen were made out of obsidian (Choe et al. 1992). There are no blank type I cores among the finds, while as many as ten are of blank type II, one is of type III, and six are of type IV. Blades detached from the type III blank may not be microblades in the strict sense since the width of the largest is around 10 mm (no. 11).

Specimens assigned to type II blanks include one obsidian core from which blades were produced in two directions at roughly a right angle to each other (no. 17), although it is not possible to determine the mode of platform preparation. Along with Sokchang, the Hahwagye sample has a relatively high percentage (35 percent) of blank type IV specimens. Five blank type II cores and three blank type IV cores were used to detach microblades at acute angles. The percentage of blade production at an acute angle is the highest at Hahwagye (50 percent), compared with 29 percent at Sokchang and 17 percent at Suyanggae.

Sangmuryong is a Pleistocene terrace surrounded by the high mountains in Kangwon-do (Choe 1989). Although only two artifacts were identified as microblade cores out of more than 7000 stone artifacts, there are hundreds of obsidian tools and fragments. A microblade core from this site (no. 9) was used to produce

TABLE 3. MICROLITHIC LOCALITIES AND TYPES OF MICROBLADE CORE BLANKS

	I (%)	II (%)	III (%)	IV (%)	UNDETERMINED	TOTAL
Mandal	0 (0)	5 (71)	2 (29)	0 (0)	0	7
Sangmuryong	0 (0)	1 (50)	1 (50)	0 (0)	0	2
Hahwagye	0 (0)	10 (59)	1 (6)	6 (35)	2	19
Sokchang	3 (23)	5 (38)	1 (8)	4 (31)	0	13
Suyanggae	16 (59)	11 (41)	0 (0)	0 (0)	0	27
Songjeon, Okkwa	0 (0)	2 (100)	0 (0)	0 (0)	1	3
Keumpyoung	0 (0)	0 (0)	1 (100)	0 (0)	0	1
Juksan	0 (0)	1 (100)	0 (0)	0 (0)	0	1
Taejon	2 (67)	1 (33)	0 (0)	0 (0)	0	3
Kokcheon	0 (0)	2 (100)	0 (0)	0 (0)	0	2
Imbul	0 (0)	2 (100)	0 (0)	0 (0)	0	2
Jungdong					1	1
Jusan, Okkwa					1	1
Kulpo					1	1
Total	21	40	6	10	7	83

Percentages were calculated without counting undetermineds.

microblades that were detached at both edges of the core. The platform appears to have been made by transversal blow and formed by heavy trimming.

Suyanggae

Thousands of stone artifacts, including 195 microblade cores were found at Suyanggae, one of the most important Upper Palaeolithic localities in Korea (Lee 1984, 1985, 1989). According to the report, 168 cores were made of siliceous shale, fourteen of obsidian, and nine of porphyry (Lee 1989). The excavators conclude that around half of the microblade cores were made by bifacial retouching and subsequent longitudinal flaking (Lee and Yun 1992*a*). However, among the 195 cores, only twenty-seven (including an unfinished one) are available for discussion.

Microblade technology at Suyanggae was largely represented by type I, or bifacially retouched elongated, blanks. Out of total twenty-seven reported cores, sixteen have type I blanks while the other eleven have type II blanks. As shown in Table 3, Suyanggae samples make up 76 percent of all type I cases. Type I blanks were most likely combined with type A platform preparation, although there are many cases in which modes of platform preparation cannot be determined because of the lack of illustrations. One specimen, no. 46 in Table 2 (Fig. 5) was manufactured by type A3 platform preparation, that is, by dividing the blank in half with a hard longitudinal blow, a variety called the Horoka technique in Japan. Specimens no. 33 and no. 44 (unfinished) shown in Figure 5, suggest that pressure was applied against the platform surface at an acute angle of approximately 130°.

Among eleven microblade cores made with blanks that can be classified into type II, some specimens retain natural cortex surface (nos. 31, 32, and 53, Fig. 8). The majority of blank type II specimens employed type A, a longitudinal blow, to detach ski-spall flakes in order to prepare platforms. Some, however, used

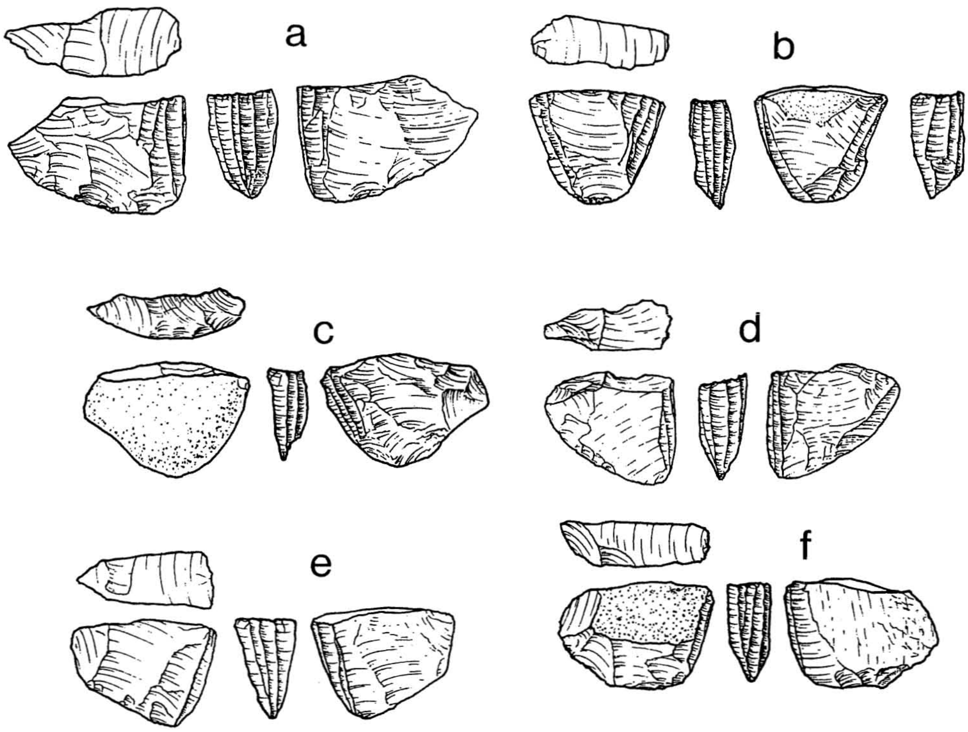

Fig. 8. Microblade cores from Suyanggae (blank types III). a: no. 54; b: no. 51; c: no. 32; d: no. 42; e: no. 31; f: no. 53. (Redrawn based on original reports; not to scale; numbers refer to Table 2.)

other techniques. Specimen 31, for example, which has a unifacial blank with a D-shaped cross section, has evidence of a transversal blow and subsequent trimming to create points suitable for applying pressure to detach microblades. Specimen 32, shown in Fig. 8, has ambi-polar blade production faces on the core. This case of using both edges is also seen in a Sangmuryong specimen (no. 9, Fig. 6) and in a core found at Kokcheon (no. 80).

There are as many as four unfinished specimens among the twenty-seven Suyanggae microblade cores (nos. 36, 41, 44, and 50 in Table 2). Among them, specimen 44 (Fig. 5), very similar to no. 50 in both shape and size, shows the characteristics of type I blanks that were refitted with two ski-spall flakes and one flake that had been removed for blade production. Although no blades were detached from specimen 44, the core closely resembles specimen 55, from which at least six microblades were removed. Thus, we must include these unfinished specimens in examinations of microblade cores, since they may have significant implications, particularly regarding the issue of technological variation and core exhaustion.

One may ask why these cores were discarded before they were used. The answer may reflect the following hypothetical circumstances: mistakes were made in preparing the core; concealment or storage of objects for future use, but that were never used; or the abundance of raw materials around the site. The issue may be best addressed with regard to site function, although this requires more intensive research and is beyond the range of the present analysis. Mistakes could be ruled out for the Suyanggae case, because the resemblance between specimens 44 (no blades were detached) and 55 (at least six blades were produced) suggests that similar examples were successfully used to obtain microblades. According to the excavators (Lee and Yun 1992*a*), the main raw material, siliceous shale, is readily available 1.5 km from the locality. The abundance of raw materials is also indicated by so-called "heavy-duty tools" such as hand-axes, although they may have a different depositional context than the microliths.

Sokchang

Eleven microblade cores were uncovered at Sokchang. While the discovery of microblade cores was announced in various papers by the excavator (Sohn 1968, 1973*a*, 1973*b*), they did not draw much attention. According to the most recent report (Sohn et al. 1994), sixteen microblade cores were uncovered, of which five were collected on the surface. Associated with these microblades and cores are points, end-scrapers, and burins.

Various types of raw materials and different technical approaches were used to produce microblades. Among the cases presented here, three are of type I blanks, five are of type II, one is of type III, and four are of type IV. Two blank type I cores were made of quartz-feldspar porphyry (Sohn 1968), one of which (no. 60, Fig. 5) was probably discarded before any blades were detached. Type A platform preparation was suggested by the presence of flakes known as ski-spalls. The other type I (no. 62, Fig. 5) blank has a more complicated platform surface, which was probably made by a transversal blow and subsequent trimming from various directions.

While Sokchang has a complicated stratigraphy, as described in the report, it appears that microlithic artifacts were found at the top of a dark gray layer with typical soil wedges. Artifacts collected from the surface might have been moved by plowing; this surely is the case with Hahwagye and other southern Korean localities. A radiocarbon date from the deposit suggests that human occupation at the site is as old as 20,000 B.P., which would be one of the oldest microlithic industries in northeast Asia. However, the date does not correspond with the result of pollen analysis (Nelson 1993: 49–50). Although the excavators themselves emphasize the possibility of the Mesolithic date, considering the fact that microlithic assemblages are confined to the top portion of the Pleistocene deposit and some surface collection, however, it may be dated to the terminal Pleistocene.

Localities in Southern Korea

In the late 1980s and early 1990s, many late Palaeolithic sites were discovered and excavated in the southern part of the Korean peninsula. Surface survey and subsequent excavations by the Juam salvage archaeology project in the Boseong River valley exposed several small-scale microlithic localities, Keumpyoung (Lim and Yi 1988), Kokcheon (Lee and Yun 1990; Lee et al. 1988*b*, 1989), Juksan (or Deoksan, Yi et al. 1990*b*), and Taejon (Lee et al. 1988*a*, 1992). Similar sites were known and excavated on Pleistocene terraces at Okkwa (two localities, Jusan and Songjeon, Yi et al. 1990*a*) and Imbul, Geochang (C. An 1988; Nakamura 1989).

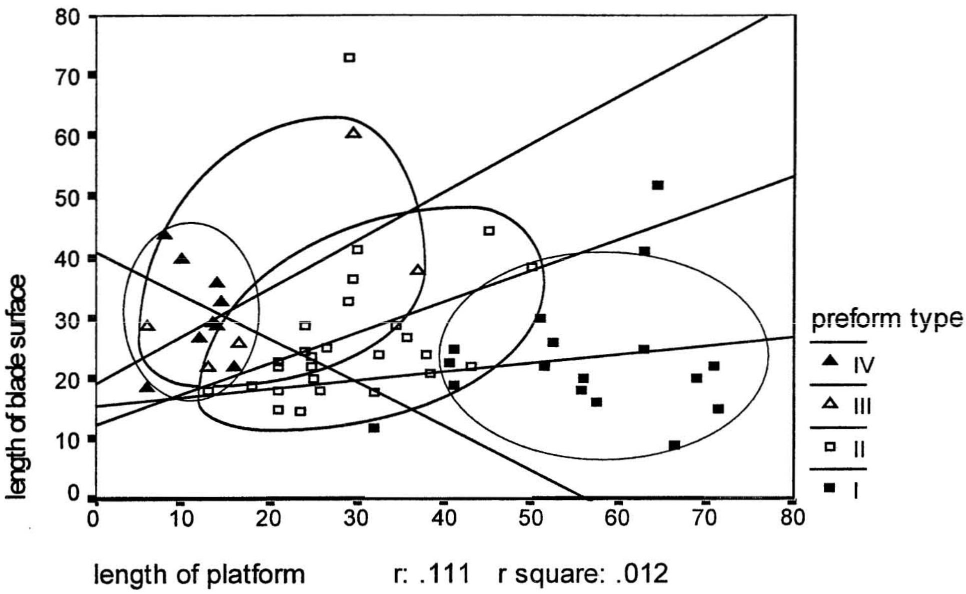

Fig. 9. A statistical relationship between the lengths of platform and blank surface for the four types of blanks. (Individual measurements and the identifications of four blank types are shown in Table 2.)

These microlithic sites in southern Korea are located close to each other, within a 50 km radius (Fig. 2), and share many common characteristics. This high density of sites may be expected to occur elsewhere as systematic surveys and excavations are conducted on a regional scale.

The stone artifacts from the sites are distributed in small areas regardless of the size of their associated Pleistocene terraces. No localities have yielded more than three microblade cores. Taejon has two blank type I cores, while no other sites have blank type I cores in the southern part of Korea. Blank type II appears dominant. As illustrated by the specimen from Songjeon, Okkwa (no. 68 in Table 2, with a ski-spall refitted), type A platform preparation was most widely used. In this example, a platform was created and microblades were removed simply on a flake of hornfels (the raw material may need to be reidentified). Suitable flakes were used with or without further trimming on the surface. One Imbul microblade core, however, was manufactured by platform type B, applying a transversal blow and subsequent trimming (no. 82, Fig. 6). Only one blank type III core was found at Keumpyoung. Found broken, a microblade core from Jusan, Okkwa, may be a fragment of a core of type II or III blank.

Although quartz artifacts are common as well, most assemblages at these localities are dominated by stone artifacts of tuff, which are found weathered with a yellowish green surface and darker gray interior. Most artifacts were either collected on the surface or found at the top of Pleistocene deposits with the implication that they are dated to the terminal Pleistocene period. These common characteristics lead us to conclude that microlithic industries based mainly on microblade technology were commonly held among forager groups in the southern part of the peninsula at the late Pleistocene.

A PRELIMINARY REVIEW OF TEMPORAL AND SPATIAL VARIABILITY

The temporal and spatial variability of the microlithic assemblages is a complicated issue that can be addressed by analysis that requires not only lithic data from northeast Asia, but also environmental information. However, the discussion of Korean microblade technology and microlithic assemblages provides a preliminary sketch of the microlithic tradition in northeast Asia. In drawing temporal and spatial tendencies of microblade traditions in Korea and adjacent northeast Asia, the main purpose will be directed to combining results from microlithic research and the various issues stated in the present analysis of microblade technology.

Spatial Variability of Microlithic Technology

It is generally believed that the microliths spread throughout Northeast Asia rapidly. However, we can draw a different picture of the further dispersal of this technology into north China, Siberia, and Japan. Although the northeast Asian microlithic shares many common features, it certainly represents differences in raw materials and lithic technology. This regional (large scale, for example, Siberia, north China, Japan) and local (small scale, for example, Korea, discussed below), difference has been largely unreported in previous studies, emphasizing mainly homogeneity of the northeast Asian microlithic. I will briefly survey the regional differentiation in northeast Asia and discuss the same topic of local variation of the Korean Upper Palaeolithic with regard to microblade technology and raw materials.

Three "technocomplexes" have been proposed for the Siberian microlithic: west Siberia (Yenisei region), east Siberia (Angara and Baikal region), and southern Far East (Amur and Sakhalin), which is characterized by different microblade technology (Kuznetsov 1995). According to Gai (1985 : 235), while the microliths in the western areas of north China consist of rather simple and few types, they are more complex and diverse in the east. The microlithic in eastern Mongolia, in contrast to that of Salawusu in the west, includes various types of tools such as points, scrapers, and end-scrapers, as well as microblade cores.

Most Japanese scholars have divided established types into subtypes to propose finer patterns of spatial and temporal variability. As C. Suzuki (1992) proposes, two broad-scale regional traditions can be observed in the Japanese microlithic: Hokkaido and northern Honshu are characterized by wedge-shaped cores of the Yubetsu technique, and Pacific Honshu and Kyushu are dominated by prismatic and boat-shaped cores. He goes on to relate this difference to environmental and subsistence variation. Efforts to examine small-scale local variation in technology in terms of raw material availability have also been attempted: Saikai or Fukui type cores are largely confined to northwestern Kyushu, where obsidian sources are relatively abundant; the Funano type of boat-shaped cores are distributed in areas with no obsidian sources (J. Suzuki 1983; Tachibana 1983).

The Upper Palaeolithic of Korea is not an exception to this increasing regional variation in lithic industries. Differences in raw materials may be a primary factor in spatial variability in lithic technology. Despite small samples, there is growing evidence of spatial patterning. This issue is not addressed by the current typology, but the new classification presented here provides a basis to examine regional variation of microblade technology and raw materials.

While the occurrence of type I blank preparation is confined to three localities, Sokchang, Suyanggae, and Taejon, type II blanks are the most common; almost all localities have specimens assigned to this type (Table 2). Although Jusan and Keumpyoung have no cores of such type, it must be noted that each site has had only one core recovered. On the other hand, blank types of III and IV are rather minor elements. Only two sites, Hahwagye and Sokchang, have type IV microblade cores.

These differences on an interlocality scale may be accounted for by the differential availability of raw materials: (1) obsidian artifacts are common in three high latitude localities, Mandal, Sangmuryong, and Hahwagye; (2) siliceous shale is the main material for Suyanggae objects; and (3) tuff is dominant in the assemblages from the southern Korean microlithic. Quartz is most common regardless of the location, and porphyry is observed in most South Korean microlithic localities, including Suyanggae, Sokchang, Okkwa, and Taejon. For some obsidian materials, the sites of Suyanggae and Sokchang may reflect their intermediate location between northern and southern parts; this is especially true for Sokchang, where various materials and techniques were used in microlithic technology (Fig. 2 and Table 2).

The proposed relationship between material, geographic, and technological variation is as follows: (1) where obsidian is common, such as Mandal, Sangmuryong, and Hahwagye sites in the northern part of the peninsula, larger proportions of microblade cores are assigned to blank types III and IV; (2) Suyanggae, with its many stone artifacts made of siliceous shale, has the highest proportion of type I core blanks; and (3) microblades made out of tuff, as in many localities in southern Korea, are most commonly produced from blanks of type II. This pattern of regional variation will be more firmly established with increasing research and the accumulation of additional data.

This sketch of regional variation in Korea along with adjacent areas in northeast Asia may be a key to understanding the development of microlithic industries. While the region of northeast Asia in the late Pleistocene shared a relatively common lithic industry, indicating the selective advantage of the microliths in a variety of environments, inter- and intra-regional variation increased, and regional differences developed further as local traditions diversified. These regional differences were eventually restructured by the early Neolithic in northeast Asia.

In the case of the archaeological record from Korea, however, larger samples are needed to draw a more reliable regional patterns of association of raw materials and microblade technology. Related to this problem is the uneven quantity and quality of archaeological research in the region: few detailed analyses of microlithic assemblages have been published, and many materials await thorough examination.

Temporal Variability of the Microlithic

Although many archaeologists focus on typology and technological reconstruction, which are important parameters for establishing comparisons on an assemblage level, another issue concerns the origins of the microlithic tradition in northeast Asia. How the question of origin is dealt with, in turn, greatly affects the establishment of chronology. In other words, all three issues—origins, chronology, and typology—are related. A robust theoretical framework will be needed to provide the justification of methodological and technical aspects of the analysis, that is, to connect seemingly separate issues together.

On the Origin of the Microlithic Tradition in Northeast Asia: —It is generally believed that microlithic industries originated in the relatively northern part of Northeast Asia and then spread into more southerly areas. North China and Siberia are the candidates for the possible place for microlithic origin.

Many Russian archaeologists favor a Siberian origin hypothesis, mainly based on the alleged technological development from the local Mousterian Levallois technology to the microlithic (Larichev et al. 1990, 1992). However, we need to be careful in tracing continuities or developmental sequences, since the difference between the Levalloisian and the microlithic is quite obvious: most prominently, they contrast by using direct and indirect percussion respectively (Gai 1985). Some (Mochanov 1978, 1980) regard the "Dyuktai (D'uktai) Culture," dating to 35,000 B.P., as one of the oldest traditions of the microlithic. While Mochanov's chronology is still accepted by Russian archaeologists (Larichev et al. 1992), the dating is unreliable on both geological (Yi and Clark 1985) and typological (Chen and Wang 1989) grounds. Yi and Clark conclude that there is no secure evidence for the Siberian Upper Palaeolithic predating 20,000 B.P. Mochanov (1980 : 128–129) himself, however, proposes the area between Huanghe and the Amur River as the location for the origin of the microlithic sometime between 40,000 and 35,000 B.P. He argues that yet undiscovered local Neanderthals developed into modern humans and developed a specific Upper Palaeolithic culture—the Dyuktai culture.

Many Chinese archaeologists (An 1978; Chen 1984; Gai 1985; Tang and Gai 1986) present Shiyu and Xiachuan as the earliest microlithic sites to support the hypothesis of a north Chinese origin. However, Shiyu, which is dated to around 28,000 B.P., has no typical microblades, while blades, scrapers, burins, and points were found at the site, and there are doubts about the reliability of the Xiachuan radiocarbon dates of ca. 24,000–16,000 B.P. (Kato 1992). A more controversial hypothesis seeks the origin in terms of continuity from "small tool tradition" as proposed by Jia et al. (1972; see also Gai 1985; Jia and Huang 1985). The tradition consists of lithic assemblages found in a series of Palaeolithic sites, including Zhoukodian, Xujiayao, Shiyu, and Xiaonanhai, and it is seen as culminating in the typical microlithic. However, a sequence of Palaeolithic assemblages cannot be based simply on the size of stone artifacts (Madsen et al. 1996; Yi and Clark 1983). Microlithic assemblages themselves have some components of larger tools, such as hand-axes and choppers, as exemplified by Suyanggae, Okkwa, and other localities.

Although we should note that "microliths" found at Salawusu (Sjara-osso-go) in southern inner Mongolia (Fig. 1) dated to slightly over 35,000 B.P. by radiocarbon and uranium series techniques (Gai 1985), no typical microblade cores were discovered (Kato 1988 : 11) and little sound evidence has been presented to support the various hypotheses. The debate over the beginning of the microlithic is plagued by the distinctive regional research traditions or biases in the archaeology of northeast Asia. Most attempts to propose microlithic origins have been devoted to finding the oldest site and the most primitive form in a search for the original occurrence. But, in a strict sense, this is not possible, because archaeology cannot detect every archaeological event throughout all time periods. We can only construct plausible descriptions of chronological dispersal on the basis of selected samples of human occupation.

Discussions that focus on identifying which form is more primitive are purely descriptive, and cannot provide accounts for why the microlithic industry originated and dispersed. As implied in the discussion of Russian archaeology, it is possible to find microblade-like materials in Middle Palaeolithic assemblages. How to explain the existence of microliths in industries that are currently assumed to be Mousterian age? However detailed the chronology and typology may be, this does not constitute an explanation. The explanation of origin lies in providing causation for why and how microliths persisted and dispersed into the various areas of northeast Asia, and this is a matter of theory. A theory provides an explanatory framework for the appearance of new variation (the microlithic) in the previous lithic assemblages, its increasing popularity, and disappearance. The evolution of microlithic industries can be understood in terms of the sequence in which new variation is generated and selected and finally disappears, as evolutionary theory stipulates.

Chronology of the Microlithic in Korea

Little effort has been exerted to derive chronological sequences from Korean archaeological data. Only a few sites yielded absolute dates. The exceptions are Sokchang and Suyanggae, which have radiocarbon dates of ca. 20,000 and 16,000 B.P. respectively (Lee 1985, 1989; Lee and Yun 1992*a*).

Aside from absolute dates, it has been extremely difficult to derive a chronological order for microlithic localities in the Korean peninsula. A consideration of stratigraphic evidence may be the most useful way to determine age. Most artifacts are from surface collection, which is especially true for most localities in southern Korea and Hahwagye. The lithics found in situ are often confined to the top portion of the Pleistocene terrace deposits. The abundance of surface collections and the shallow distribution within the Pleistocene deposits suggests that most microlithic industries date to the final stage of the Pleistocene, probably between 15,000 and 10,000 B.P. (Yi et al. 1990*a*).

We may apply another criterion, changes in technological traits of the lithic assemblages, in order to detect chronological order among the localities, limiting cases to those localities that yielded three or more measurable microblade cores. Given the relatively earlier absolute date for Suyanggae, the results indicate the following order of localities from older to younger: Suyanggae, Sokchang, Hahwagye, and Mandal. This in turn suggests that type I blank preparation is associated with the oldest form of manufacturing microblades with some co-occurrence with other techniques.

The change from type I to type II cores might be understood if we compare the technological efficiency of types I and II: more time and energy were devoted to the preparation of type I microblade cores. This can be tested by examining the number of blades detached from the core classified by blank types. The average number of blades from type I cores (3.94 per core) is smaller than that from type II cores (5.10). Even more blades were detached from type III (7.83) and type IV (8.00) cores. If we accept the proposition that selection favors increasing efficiency in manufacturing microblades through time, we could infer a temporal order of microblade production approaches in which type I cores are older than type II cores, but both types I and II are older than types III and IV cores. This chronological order roughly corresponds with the previous result, which assigns Suyanggae and Sokchang to an earlier interval than Hahwagye and Mandal. Nonetheless, this hypothesis requires additional testing.

SUMMARY AND CONCLUSIONS

The history of microlithic research reveals a shift from arbitrary intuitive arrangements of microblade cores to more detailed technological analyses with some experimental studies. This in turn provides a basis for regional comparison of microblade cores in terms of technological variation. However, it is also true that the current emphasis on a fixed typology of reconstructed manufacturing-related types for microblade cores is inappropriate for covering the full range of technological variation. Identification of new finds with the established typology is the main subject of current research regarding microblade technology. Cores are only the complex residuals of blade production process rather than deliberately made tools.

In order to examine technological diversity more systematically, this study explicitly employs the concept of a reduction sequence using microblade cores found in the Korean peninsula. We observed three basic steps of microblade manufacture that resulted in four variants of blank formation, three different approaches to platform preparation, and three forms of blade detachment location, including two classes of blade producing angle. By intersecting the attributes of each dimension (step), we generate thirty-six (seventy-two, including blade angle) distinctive classes of microblade production. These classes include all the different microblade techniques currently recognized in the typologies of northeast Asia.

Many Suyanggae microblade cores were produced by elaborated bifacial flaking on the elongated blanks (type I), which are most likely associated with type A platform preparation (longitudinal blow). Some of the microblade cores from Sokchang and Taejon also fall into this type of blank formation. However, the majority of microblade cores found in the Korean peninsula lack these features. Often unifacial, they were made of less flaking on the surface, implying a reduction in effort invested into microblade manufacture, or more accurately, into blank production. The time and energy associated with lithic manufacture technology may be a good productive topic for future research (see Torrence 1989).

The relationship between variation in microblade technology and raw materials in Korea indicates three regional-scale patterns: (1) a northern pattern as represented by the sites of Mandal, Sangmuryong, and Hahwagye with an abundance of obsidian objects and cores with longitudinal blade production (blank types III and IV); (2) a central pattern (Suyanggae and possibly Sokchang) with a dominance of bifacial flaking on the elongated blank (type I), which is made out of siliceous shale with minor portions of obsidian and porphyry objects; and (3) a southern pattern (Okkwa, Juksan, Kokcheon, Imbul), which is typically associated with cores of type II blanks made of tuff.

The increasing number of microlithic localities and the accumulated data from these sites suggest that the Korean peninsula witnessed an increasing density of foraging occupations at the time of the last glacial maximum during the late Pleistocene. The chronology, however, still remains coarse, partly because of the lack of absolute dates from the region. Considering stratigraphic and geomorphological contexts, it is more likely that most microlithic localities date to the final phase of the Pleistocene.

While we need more sites and samples before we can reliably estimate the spatial and temporal aspects of the microlithic industries, these alone will not resolve all the questions posed by archaeologists. A systematic methodilogical framework for classifying and identifying technological diversity is needed, along with a theoretical basis for explaining this technological variability. The present study represents an effort in that direction.

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ABSTRACT

Research history of the microlithic in northeast Asia reveals that while heavy emphasis has been placed upon reconstructing microblade techniques, little effort has been made in providing a systematic framework for examining microlithic technology. This study attempts to present an inclusive classification system of microblade technology based on the concept of reduction process. Technological classes are obtained by intersecting several types from three (or four) dimensions: blank formation (I, II, III, IV), platform preparation (A, B, C), and blade detachment (location and angle, a, a_1, b, b_1, c, c_1). Some eighty microblade cores reported from ten Korean localities are analyzed. Variation of Korean microblade technology is closely associated with regional-scale differences in raw material availability, and three patterns are suggested: a northern pattern of obsidian type III and IV cores as shown in Mandal, Sangmuryong, and Hahwagye materials; a central pattern with a high portion of elongated bifacial cores made of siliceous shale as represented by Suyanggae (and possibly Sokchang); and a southern pattern typically associated with type II tuff cores. Only a few samples of absolute dates are available for Korean microlithic assemblages, while the overwhelming amount of surface collections and limited distribution to the top of Pleistocene deposits suggest that most Korean microliths can be dated to the final Pleistocene. KEYWORDS: microblade core, microblade technology, reduction sequence, Korea, northeast Asia.